The documentation and process conversion measures necessary to comply with this revision shall be completed by 30 December 1993

INCH-POUND

MIL-S-19500/347A
30 July 1993
SUPERSEDING
MIL-S-19500/347(NAVY)
20 April 1966

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
TYPES: 2N3253, 2N3253S, 2N3444, 2N3444S, JAN, AND JANTX

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for NPN, silicon, power, transistors. Two levels of product assurance is provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1.

1.3 Maximum ratings.

Type	P_T		V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_{OP}
	T_A = +25°C 1/	T_C = +25°C 2/					
	W	W	V dc	V dc	V dc	A dc	°C
2N3253,S	1.0	5.0	75	40	5	1	-65°C to +200°C
2N3444,S	1.0	5.0	80	50	5	1	-65°C to +200°C

1/ Derate linearly 28.6 mW/°C for T_A > +25°C.
2/ Derate linearly 5.71 mW/°C for T_C > +25°C.

1.4 Primary electrical characteristics.

	h_{FE2} I_C = 500 mA dc, V_{CE} = 1 V dc 1/		h_{FE3} I_C = 1 A dc, V_{CE} = 5 V dc 1/		C_{obo} V_{CB} = 10 V dc, f = 100 kHz		$\lvert h_{fe} \rvert$ I_C = 50 mA dc, V_{CE} = 10 V dc, f = 5 MHz		$V_{BE(sat)2}$ I_C = 500 mA dc, I_B = 50 mA dc 1/		$V_{CE(sat)2}$ I_C = 500 mA dc, I_B = 50 mA dc 1/	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
					pF				V dc		V dc	
2N3253, S	25	75	20		12		17	50	0.7	1.3		0.6
2N3444, S	20	60	15		12		17	50	0.7	1.3		0.6

1/ Pulsed (see 4.5.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronic Supply Center, ATTN: DESC-ECT, 1507 Wilmington Pike, Dayton, OH 45444-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5961

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications, and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

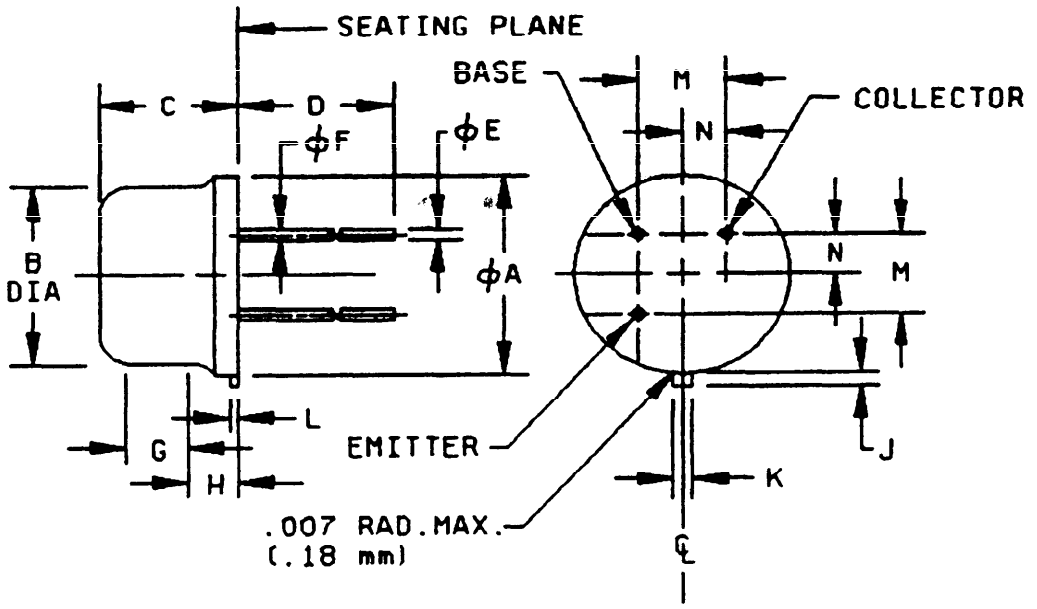
a. Total control charge Q_T When a transistor is held in a conductive state by a current, I_B, a charge Q_S is stored in the device when operating in the active region. A charge Q_T may be stored on an external capacitor C to neutralize the effect of the internal charge, Q_S when the transistor is turned off (see 4.4.1.1).

b. Base leakage current. (I_{BL}) is defined as base leakage current with both junctions reverse biased. I_C is always $\leq I_{BL}$ for $V_{BE} \geq V_T$. (V_{BE} is off condition base bias; V_T is base voltage at threshold of conduction.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, and figure 1 herein. The suffix "S" is used on devices which have 0.5 inch minimum to 0.75 inch maximum lead length.

3.3.1 Lead material and finish. Lead material shall be Kovar, Alloy 52 or approved equivalent. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-S-19500 and as specified herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.3.2 Terminal-lead length. Terminal-lead length(s) other than that specified in figure 1 may be furnished when so stipulated in the contract or order. Where other lead lengths are required and provided, it shall not be construed as adversly affecting the qualified-product status of the device, or applicable JAN marking (see 6.2).



Ltr	Dimensions				Notes	Ltr	Dimensions				Notes
	Inches		Millimeters				Inches		Millimeters		
	Min	Max	Min	Max			Min	Max	Min	Max	
ϕA	.335	.370	8.51	9.40		H					6
B	.305	.335	7.75	8.51		J	.029	.045	0.74	1.14	9
C	.240	.260	6.10	6.60		K	.028	.034	0.71	0.86	
D	See notes				10,11,12	L	.009	.125	0.23	3.18	
ϕE	.016	.021	.41	.53	3,10	M	.1414 Nom		3.59 Nom		7
ϕF	.016	.019	.41	.48	4,10	N	.0707 Nom		1.80 Nom		7
G	.100		2.54		5						

FIGURE 1. Physical dimensions.

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
4. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
5. Variations on dimension B in this zone shall not exceed .010 (0.25 mm).
6. Outline in this zone is not controlled.
7. When measured in gauging plane .054 +.001, -.000 (1.37 +0.03, -0.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 shows the preferred method of measurement.
8. The collector shall be electrically connected to the case.
9. Measured from the maximum diameter of the actual device.
10. All 3 leads (see 3.3.1 and 3.3.2).
11. For transistor types 2N3253 and 2N3444, dimension L shall be 1.500 inches (38.10 mm) minimum and 1.75 inches (44.4 mm) maximum.
12. For transistor types 2N3253S and 2N3444S, dimension L shall be 0.5 inches (13 mm) minimum and 0.75 inches (19.0 mm) maximum.

FIGURE 1. Physical dimensions - Continued.

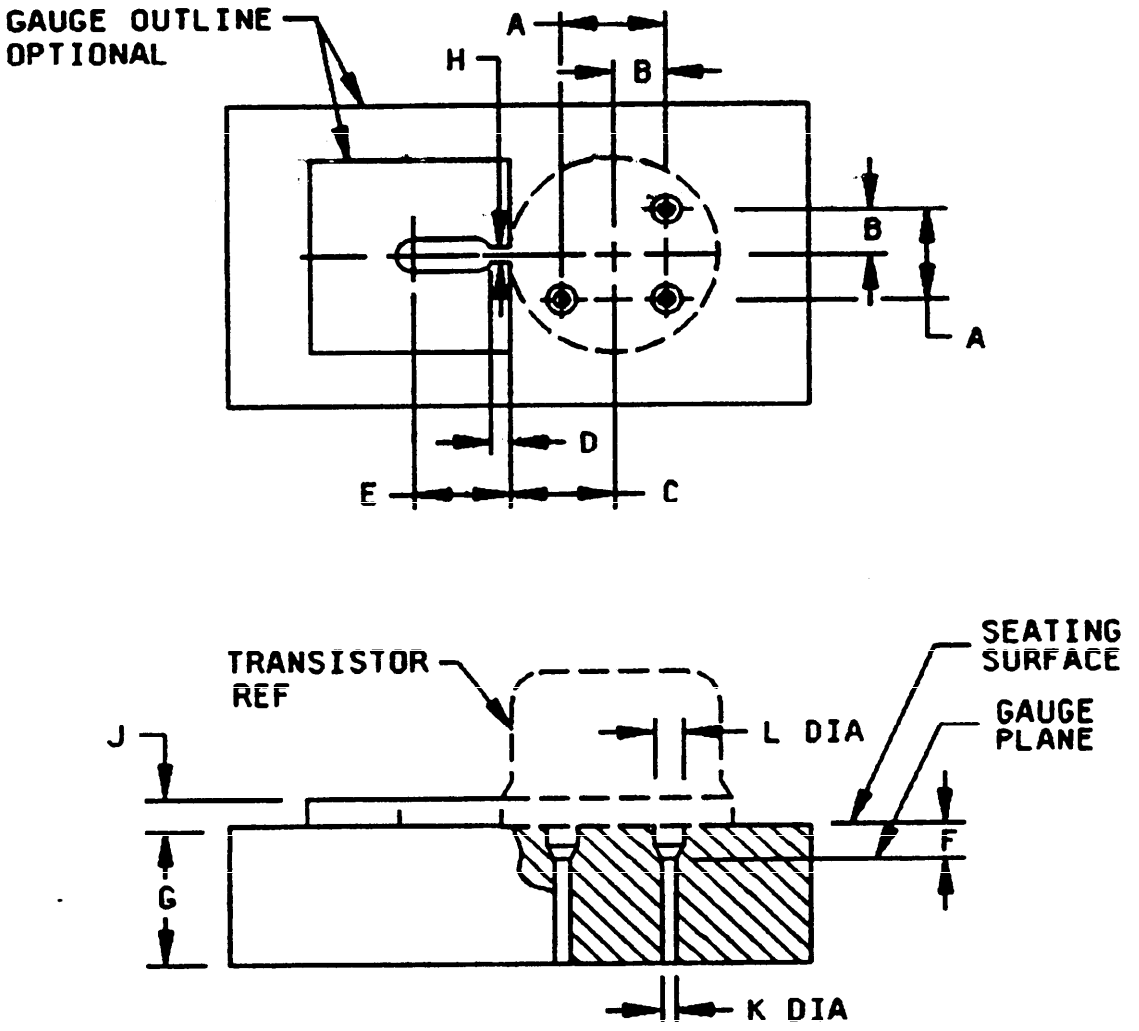


FIGURE 2. Gauge for lead and tab location.

Dimensions				
Ltr	Inches		Millimeters	
	Min	Max	Min	Max
A	0.1409	0.1419	3.58	3.60
B	0.0702	0.0712	1.78	1.81
C	0.182	0.199	4.62	5.05
D	0.009	0.011	0.23	0.28
E	0.125 Nom		3.18 Nom	
F	0.054	0.055	1.37	1.40
G	0.372	0.378	9.45	9.60
H	0.035	0.0355	0.89	0.90
J	0.150 Nom		3.81 Nom	
K	0.325	0.0335	0.83	0.85
L	0.0595	0.0605	1.51	1.54

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The following gauging procedure shall be used: The use of a pin straightener prior to insertion in the gauge is permissible. The device being measured shall be inserted until its seating plane is .125 ±.010 (3.18 ±0.25 mm) from the seating surface of the gauge. A spacer may be used to obtain the .125 (3.18 mm) distance from the gauge seat prior to force application. A force of 8 oz ±.50 oz shall then be applied parallel and symmetrical to the advice's cylindrical axis. When examined visually after the force application (the force need not be removed), the seating plane of the device shall be seated against the gauge.
4. The location of the tab locator, within the limits of dimension 3, will be determined by the tab and flange dimension of the device being checked.

FIGURE 2. Gauge for lead and tab location - Continued.

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

3.4.1 'S' suffix marking. The 'S' suffix shall be used on devices meeting the 0.5 inch minimum to 0.75 inch maximum lead length requirement.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500. Either 'S' suffix devices or non-suffix devices may be used for qualification.

4.3 Screening (JANTX level only). Screening shall be in accordance with MIL-S-19500 (table II), and as specified herein. The following measurement shall be made in accordance with table I herein. Devices that exceed the limits of tables I and II herein shall not be acceptable.

Screening (see table II) of MIL-S-19500)	Measurements JANTX level
9	Not applicable
11	I_{CBO1} and h_{FE2}
12	See 4.3.1
13	ΔI_{CBO1} = 100 percent of initial value or .05 µA dc whichever is greater; Δh_{FE} = ±15 percent of initial value; subgroup 2 of table I herein.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

T_A = room ambient in accordance with the general requirements of paragraph of MIL-STD-750.
2N3444 = V_{CB} = 40 V dc,
2N3253 = V_{CB} = 32 V dc; P_T = 1.0 W.

NOTE: No heatsink or forced air cooling on the devices shall be permitted.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVb (JANTX, and JANTXV) of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection, Table IVb of MIL-S-1950.

Subgroup	Method	Conditions
B3	1027	T_A = 25°C; V_{CB} = 10 V dc; P_T = 1.0 W.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1 Group C inspection, Table V of MIL-S-19500.

Subgroup	Method	Conditions
C2	2036	Test condition E.
C6	1026	T_A = 25°C; V_{CB} = 10 V dc; P_T = 1.0 W.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows:

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in MIL-STD-750.

4.5.2 Total control charge. The capacitor C, is adjusted to the minimum value which will produce a turn off waveform similar to the one shown in figure 3, where C = C optimum. The optimum capacitance is obtained when the "bumps" just disappear. The charge on the capacitor which will be called Q_T is: Q_T = C optimum V_{in}.

4.5.3 Input capacitance . This test shall be conducted in accordance with method 3240 of MIL-STD-750, except that the output capacitor shall be omitted.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Collector to emitter breakdown voltage	3011	Bias condition D; I_C = 10 mA dc; pulsed (see 4.5.1).	$V_{(BR)CEO}$			
2N3253, S				40		V dc
2N3444, S				50		V dc
Collector to base cutoff current	3036	Bias condition D	I_{CBO1}		10	µA dc
2N3253, S		V_{CB} = 75 V dc				
2N3444, S		V_{CB} = 80 V dc				
Emitter to base voltage cutoff current	3061	Bias condition D V_{EB} = 5 V dc	I_{EBO}		10	µA dc
Collector to emitter cutoff current	3041	Bias condition A V_{BE} = 4 V dc; V_{CE} = 60 V dc	I_{CEX}		0.5	µA dc
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 60 V dc	I_{CBO2}		0.5	µA dc
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc I_C = 150 mA dc; pulsed (see 4.5.1)	h_{FE1}			
2N3253, S				25		
2N3444, S				20		
Forward-current transfer ratio	3076	V_{CE} = 1 V dc; I_C = 500 mA dc; pulsed (see 4.5.1)	h_{FE2}			
2N3253, S				25	75	
2N3444, S				20	60	
Forward-current transfer ratio	3076	V_{CE} = 5.0 V dc I_C = 1 A dc pulsed (see 4.5.1)	h_{FE3}	10		
2N3253, S				20		
2N3444, S				15		
Collector-emitter saturated voltage	3071	I_C = 150 mA dc; I_B = 15 A dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.35	V dc
Collector-emitter saturated voltage	3071	I_C = 500 mA dc; I_B = 50 A dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.60	V dc
Collector-emitter saturated voltage	3071	I_C = 1.0 A dc; I_B = 100 A dc; pulsed (see 4.5.1)	$V_{CE(sat)3}$		1.2	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Base-emitter saturated voltage	3066	Test condition A; I_C = 150 mA dc; I_B = 15 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)1}$		1.0	V dc
Base-emitter saturated voltage	3066	Test condition A; I_C = 500 mA dc; I_B = 50 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$	0.7	1.3	V dc
Base-emitter saturated voltage	3066	Test condition A; I_C = 1.0 A dc; I_B = 100 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)3}$		1.8	V dc
Subgroup 3						
High temperature operation		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 60 V dc	I_{CBO2}		75	µA dc
Low temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc I_C = 150 mA dc; pulsed (See 4.5.1)	h_{FE4}			
2N3253, S				12		
2N3444, S				10		
Subgroup 4						
Pulse response:	3251	Test condition A				
Delay time		V_{CC} = 30 V dc; V_{EB} = 2 V dc; I_C = 500 mA dc; I_{B1} = 50 mA dc (See figure 3)	t_d		15	ns
Rise time		V_{CC} = 30 V dc; V_{EB} = 2 V dc; I_C = 500 mA dc; I_{B1} = 50 mA dc (See figure 3)	t_r		35	ns
Storage time		V_{CC} = 30 V dc; I_{B1} = I_C = 500 mA dc; I_{B2} = 50 mA dc (See figure 3)	t_s		40	ns
Fall time		V_{CC} = 30 V dc; I_{B1} = I_C = 500 mA dc; I_{B2} = 50 mA dc (See figure 3)	t_f		30	ns

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Base leakage current		V_{CC} = 60 V dc; V_{EB} = 4 V dc; (See 4.5.2)	I_{BL}		0.5	µA dc
Extrapolated unity gain frequency	3306	V_{CE} = 10 V dc; I_C = 50 mA dc; f = 100 MHz	$\|h_{fe}\|$	17	50	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; f = 1 MHz	C_{obo}		12	pf
Input capacitance	3240	V_{EB} = 0.5 V dc; f = 1 MHz (See 4.5.3)	C_{ibo}		80	pf
Total control charge		V_{CC} = 30 V dc; I_C = 500 mA dc; I_{B1} = 50 mA dc (See figure 4)	Q_T		5	n Coulombs
Subgroup 5						
Not applicable						

1/ For sampling plan, see MIL-S-19500.

TABLE II. Groups B and C electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to base cutoff current	3036	Bias condition D V_{CB} = 60 V dc	I_{CBO1}		0.50	µA dc
2.	Collector to base cutoff current	3036	Bias condition D V_{CB} = 60 V dc	I_{CBO3}		2.5	µA dc
3.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc I_C = 500 mA dc Pulsed (see 4.5.1)	h_{FE2}			
	2N3253, S				25	75	
	2N3444, S				20	60	
4.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc I_C = 500 mA dc Pulsed (see 4.5.1)	Δh_{FE2}	±25% change in initial recorded value		

1/ The electrical measurements for table IVb (JANTX) of MIL-S-19500 are as follows:

a. Subgroup 2, table II herein, steps 1 and 3.

b. Subgroup 3, table II herein, steps 1 and 3.

c. Subgroup 6, table II herein, steps 2 and 4.

2/ The electrical measurements for table V of MIL-S-19500 are as follows:

a. Subgroup 2, table II herein, steps 1 and 3.

b. Subgroup 3, table II herein, steps 1 and 3.

c. Subgroup 6, table II herein, steps 2 and 4.

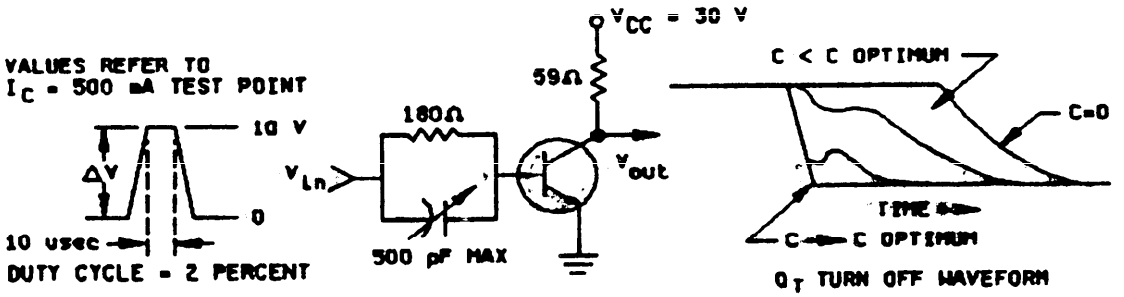


FIGURE 3. Q_T test circuit.

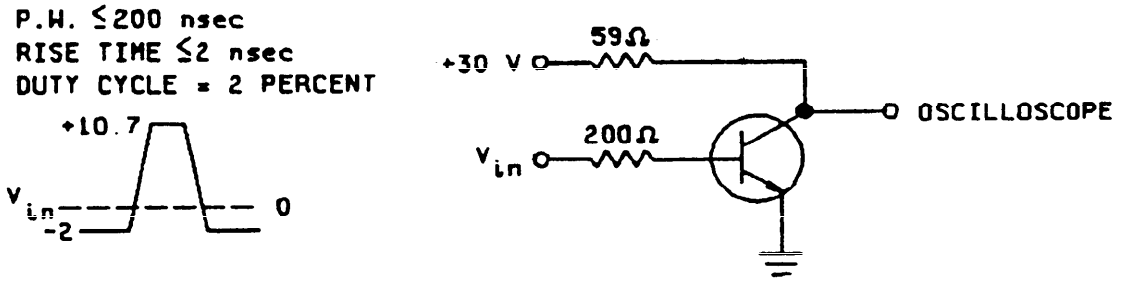


FIGURE 4. Equivalent circuit for measuring delay and rise times.

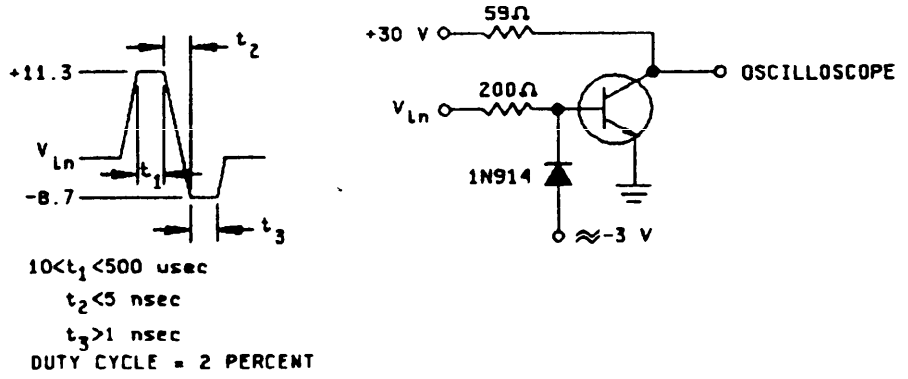


FIGURE 5. Equivalent circuit for measuring storage and fall times.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

c. Type designation and quality assurance level.

d. Terminal-lead length (see 3.3.2).

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Air Force - 85, 99
DLA - ES

User activity:
Navy - AS, CG, MC, SH

Preparing activity:
Navy - EC

Agent:
DLA - ES

(Project 5961-1393)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/347A	2. DOCUMENT DATE (YYMMDD) 930730

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER, TYPES 2N3253, 2N3253S, 2N3444, 2N3444S, JAN and JANTX

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	e. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

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c. ADDRESS (Include Zip Code) 1507 Wilmington Pike Dayton, Oh. 45444-5270	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340